Model: CAT1

Microprocessor Controlled Two-Wire 4-20mA Loop Powered Transmitter

USER'S MANUAL

HP-310
April 2009

HOFFER FLOW CONTROLS, INC.
PERFECTING MEASUREMENT

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During installation, care must be taken to select the correct interconnecting wiring drawing. The choice of an incorrect connection drawing may result in damage to the system and/or one of the components.

Please review the complete model number of each item to be connected and locate the appropriate manual(s) and/or drawing(s). Identify all model numbers exactly before making any connections. A number of options and accessories may be added to the main instrument, which are not shown on the basic user wiring. Consult the appropriate option or accessory user manual before connecting it to the system. In many cases, a system wiring drawing is available and may be requested from HOFFER FLOW CONTROLS.

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1. Introduction

The CAT1 is a microprocessor based loop powered transmitter. The transmitter accepts a low-level frequency signal on the input and provides a 4-20mA analog output proportional to the flow rate. CAT1 is compatible with all Hoffer turbine flowmeters as well as the H.O.G. series positive displacement flowmeters.

The CAT1-L model provides for 20-point linearization of the flow input signal and outputs a linearized analog current. CAT1 is fully configurable via an RS232 communications port located under the top plate. CAT configuration software is a Windows based application that provides the interface for entering K-factors, frequencies, the timebase for rate measurement, and calibration of the analog output. Configuration and remote monitoring can also be performed using any PC based communications program (e.g., HyperTerminal) or ASCII terminal.

The standard unit is packaged in an extruded aluminum enclosure for wall mounting or may be mounted directly on a flowmeter using an optional NEMA 4X or EX enclosure. An optional bracket is also available for mounting on standard DIN rail.

This instrument is designed to conform to the EMC-Directive of the Council of European Communities 89/336/EEC and the following standards:

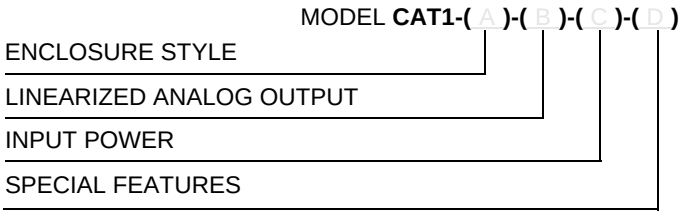
Generic Emission Standard EN 50081-1
Residential, Commercial & Light Industry Environment.

Generic Emission Standard EN 50081-2
Industrial Environment.

Generic Immunity Standard EN 50082-1
Residential, Commercial & Light Industry Environment.

Generic Immunity Standard EN 50082-2
Industrial Environment.

1-1 Model Number Designation



ENCLOSURE STYLE

MODEL **CAT1-(A)-(_)-(_)-(_)**

OPTION (A)

(1) GENERAL PURPOSE.
2.6"L X 2.6"H X 2.6"W MINIMUM MOUNTING SPACE.

(D) 2" LONG DIN RAIL MOUNT SINGLE UNIT.
UP TO 20 CAT1 UNITS CAN BE MOUNTED ON A SINGLE RAIL.
ADD 2" PER UNIT.

(3/O) MEETS CLASS 1, DIV. 1 AND 2, GROUPS C, D
CLASS II, GROUPS E, F, G
CLASS III
NEMA 4X WITH 'O' RING
CERTIFIED CSA, UL
BODY KILARK #GECCT-3, STOCK #200-0945
FLAT COVER, STOCK #200-0533, KILARK #GECBC

(3B/O) MEETS CLASS I, DIV. 1 AND 2, GROUPS A, B, C, D
CLASS 1, ZONES 1 AND 2, GROUPS IIB + H2, IIA
CLASS II, DIV. 1 AND 2, GROUPS E, F, G
CLASS III
NEMA 3, 4, 7 (B, C, D), 9 (E, F, G)
CERTIFIED CENELEC, CSA, UL, FM
BODY KILARK #HKB, STOCK #200-0406
FLAT COVER , STOCK #200-0773, KILARK #HKB-B.

(3B/O-ATEX) EExd II C ENCLOSURE. ATEX-APPROVED 3/4" FNPT
CABLE ENTRIES.

LINEARIZED ANALOG OUTPUT

MODEL **CAT1-(__)-(B)-(__)-(__)**

OPTION (B)

(7) 4 TO 20 MA UP TO 20 POINTS.
ACCURACY +/-0.02% OF FULL SCALE.

INPUT POWER

MODEL **CAT1-(__)-(__)-(C)-(__)**

OPTION (C)

(D) 8 TO 24 VDC LOOP POWERED.

SPECIAL FEATURES

MODEL **CAT1-(__)-(__)-(__)-(D)**

OPTION (D)

(CE) MARK REQUIRED FOR EUROPE

(SP) ANY SPECIAL FEATURES THAT ARE NOT COVERED IN THE MODEL NUMBER, USE A WRITTEN DESCRIPTION OF THE -SP.

NOTES:

1. **INPUTS: ACCEPTS MAGNETIC COIL ONLY.**
2. **WINDOWS® BASED SETUP DISC AND 6 FOOT COMMUNICATION CABLE. IF THREE OR MORE UNITS ARE ORDERED ON THE SAME PURCHASE ORDER ONE SET IS SUPPLIED AT NO CHARGE.**

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2. Specifications

Specifications

Input Signal Type:	Magnetic pick up, Contact Closure
Input frequency range:	0.2 Hz to 4 KHz
Signal level:	10 mV rms to 30 Vdc
Power supply:	Loop Power 8-30 Vdc Reverse polarity protection
Analog Output:	4-20 mA 24 mA overflow condition
Load resistance:	Max 650 Ohms at 24 Vdc
Accuracy:	+/- 0.02% of full scale @ 20^{o} C
Temperature drift:	40ppm/deg C
Communications	RS232 port for Configuration and diagnostics
Operating temperature:	-40^{o} to 85^{o} C
Humidity:	0-90% Non-condensing
Enclosure:	Extruded aluminum DIN rail mount Explosion Proof
Regulatory:	CE compliant

Options

20 point linearization

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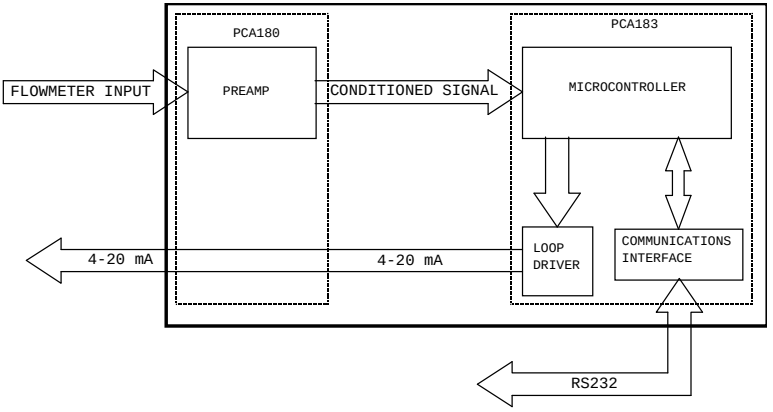
3. Principle of Operation

The CAT1 consists of two printed circuit boards and four main functional blocks: the Preamplifier, Microcontroller, Loop Driver, and Communications Interface.



3-1 Functional Blocks

3-1-1 Preamplifier

The Preamplifier, located on PCA180, accepts the input from the flowmeter. The Preamplifier applies amplification, low-pass filtering, and wave-shaping to the input signal. The wave shaping function converts the signal into a square-wave before sending it to the Microcontroller.

3-1-2 Microcontroller

The Microcontroller, located on PCA183, accepts the square-wave output of the preamplifier and performs all of the calculations that are required to control the Loop Driver. After measuring the frequency of the square-wave, the Microcontroller uses the following equations to compute the flow rate and current.

$$flowrate = \frac{frequency}{Kfactor} x60^{FM} xCF$$

Where:

Kfactor = Is dependent on the Flow Calculation Method setting and is either the Average K-Factor or the Linearized K-Factor from the Frequency / K-Factor table.

FM = Is the Flow rate Units setting of 0, 1, or 2. Where "0" is for Seconds, "1" is for Minutes, and "2" is for Hours.

CF = Is the Correction Factor setting.

$$current = 4mA + \left(16mAx\frac{flowrate}{AF}\right)$$

Where:

AF = Is the 20 mA maximum Flow rate value.

If the calculated flowrate is greater than the AF setting, the current will be set to 24mA to indicate an "Over-range" condition. After calculating the current, the Microcontroller digitally sends the current information to the Loop Driver.

3-1-3 Loop Driver

The loop driver, located on PCA183, uses the digital information sent to it by the Microcontroller to set the current of the loop. The Loop Driver also supplies power to the Microcontroller.

3-1-4 Communications Interface

The Communications Interface, located on PCA183, provides an RS232C port to the Microcontroller. The connector for the communication interface may be accessed by removing the top plate. The external terminal device provides power for the Communication Interface. The Communications Interface is used to configure and trouble-shoot the transmitter.

3-2 System Response Time

The analog output response time to reach steady state due to a change in the flow rate is approximately two (2) seconds. When flow stops, the time for the analog output to return to 4 mA will be between 3 and 12 seconds, depending on the Maximum Sample Time (MST) setting. MST is adjusted using the NB= (DATA) command, where NB is a value between 1 and 80. The default MST setting is NB= 1. Adjusting the MST is only recommended for low flow applications where the minimum input frequency is below 1 Hz.

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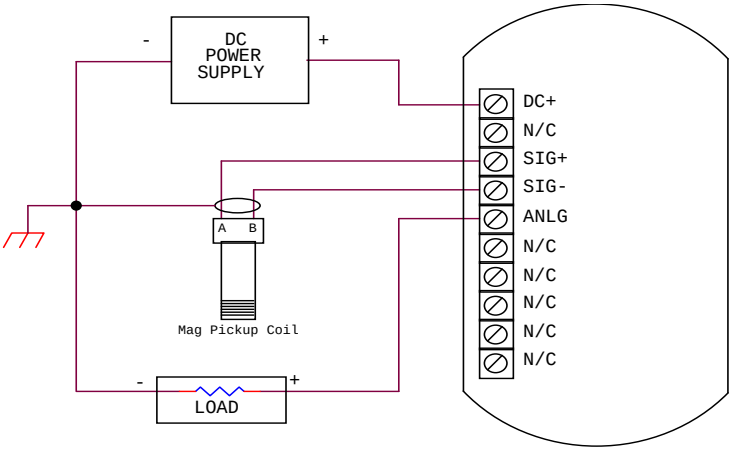
4. Installation

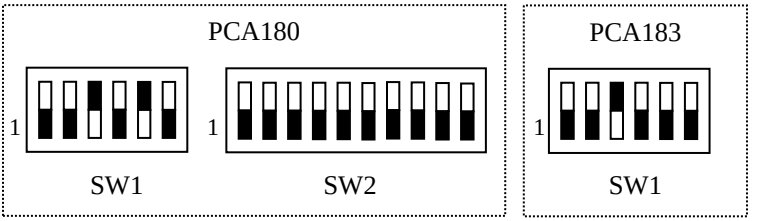
NOTE: CAT1 flow input interfaces with magnetic type pickup coils and contact closure only. If another type of coil is required, refer to CAT 2 and CAT3 models.

4-1 Typical Connections

Loop powered with MAG Coil Installation



Dip Switch Settings

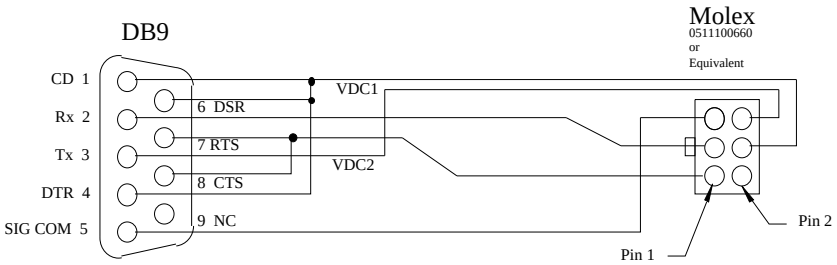


4-2 Communications Connections

The RS232 serial port connector is located under the top plate of CAT1 and may be accessed by removing the two screws from the top plate. A matching connector is provided with HOFFER HIT2A-301 Communications Cable. CAT1 unit has to be powered from external supply in order to be able to communicate. Additional power for CAT1 communication circuitry is supplied by the RS232 serial port of the computer/terminal. COM port settings must be set as follows:

Baud Rate:	2400
Data Bits:	8
Parity:	None
Stop bits:	1
Handshaking:	None

HOFFER HIT2A-301 Communications Cable



4-3 Wiring

When installing the CAT1, it is good practice to use shielded cable. The shield should be connected to earth ground near the instrument. The other end of the shield should not be connected.

In order to comply with the requirements for Electromagnetic Compatibility, as per EMC-Directive 89/336/EEC of the Council of European Community, this wiring practice is mandatory.

Appendix A – Default Configuration

Factory default configuration:

FIELD	***Value***
DN	10000000
FC	0 *(Average)*
KD	3
AK	1.00
NP	20
F01	4999.981
F02	4999.982
F03	4999.983
F04	4999.984
F05	4999.985
F06	4999.986
F07	4999.987
F08	4999.988
F09	4999.989
F10	4999.990
F11	4999.991
F12	4999.992
F13	4999.993
F14	4999.994
F15	4999.995
F16	4999.996
F17	4999.997
F18	4999.998
F19	4999.999
F20	5000.000
K01	1.00
K02	1.00
K03	1.00
K04	1.00
K05	1.00
K06	1.00
K07	1.00
K08	1.00
K09	1.00
K10	1.00
K11	1.00
K12	1.00
K13	1.00
K14	1.00
K15	1.00

14 Appendix A – Default Configuration

FIELD	*Value*
K16	1.00
K17	1.00
K18	1.00
K19	1.00
K20	1.00
TU	100 *(GAL)*
FM	1 *(MIN)*
NB	01
PA	1234
OC	0 *(Rate)*

Appendix B – Communications

Message Format And Timeout

Communication messages consist of a string of ASCII characters terminated by a carriage return character. The maximum message length received by CAT1 is 20 characters, including the carriage return. The CAT1 will transmit no more than 35 characters before transmitting a carriage return.

If a message longer than A 20 characters command is sent, the instrument responds with

"Command Sequence is Too Long!<NL>"

If an unrecognized or invalid command is sent, the instrument responds with

"Invalid Command! <NL>"

The sending unit RS232C serial port configuration must be configured as follows:

Baud rate:	2400
Data bits:	8
Parity:	none
Stop bits:	1
Handshaking:	none

The CAT1 echoes all received messages and then transmits a response string terminated with a carriage return. If the sending unit takes longer than one minute to send a message, the CAT1 aborts the message by clearing the receive buffer.

If the sending unit (PC or other such device) wishes to change a setting on the CAT1, the sending unit shall follow the command with an equal sign ("=") with the data following immediately after the equal sign. The carriage return terminates the message.

Any CAT1 response that sends data back to the sending unit shall have an equal sign ("=") followed by the data. Space is allowed between the equal sign and the data on the return message, but the total message length is limited to 35 characters.

READ Example:

If the sending unit wishes to read the number of points that the CAT1 has in the K factor table, the sending unit shall send

"NP<CR>"

The CAT1 echoes the sent message, and responds with

"NUM PTS = 2<CR>"

WRITE Example:

If the sending unit wishes to change the number of points to 20 in the K factor table, the sending unit shall send

"NP=20<CR>"

The CAT1 echoes the sent message and responds with

"NUM PTS = 20<CR>".

The CAT1 checks the ranges for data and rejects writes that are not within the allowed range. If the sending unit sends data that is not within the allowed range, the CAT1 echoes the sent message and responds with the value that is currently stored in the CAT1.

Example:

If the sending unit wishes to change the max sample time to 2000 from the previous setting of 10, the sending unit shall send

"NB=2000<CR>"

The CAT1 echoes the sent message, and responds with

"MAX M TIME= 10<CR>".

Messages

Commands Supported By Communications Messages

Command	Description/Allowed Data/Response
DN	Tag Number "0" to "99999999" "TAG NUM = (DATA)" The first three digits are the units code for total. Changing these digits will change the TU settings.
FC	Linearization "0" = Average K factor "1" = Linearization table "F C METHOD = AVG" for Average K factor or "F C METHOD = LIN" for Linearization table
KD	K Factor Decimal Point Location "0" for 00000000. "1" for 0000000.0 and all K Factors are less than 9999999.9, otherwise not allowed "2" for 000000.00and all K Factors are less than 999999.99, otherwise not allowed "3" for 00000.000 and all K Factors are less than 99999.999, otherwise not allowed "K-FAC DECL=(DATA)"
AK	Average K Factor "0.001" to "99999.999" if KD = 3 "999999.99" if KD = 2 "9999999.9" if KD = 1 " 99999999" if KD = 0 "AVG KFAC =(DATA)"
NP	Number Points in the Table "2" to "20" "NUM PTS =(DATA)"

Command	Description/Allowed Data/Response
F##	Frequency 1-20 F01 has a range of "0.000" to the value of F02 minus 0.001; F20 has a range of the value from F19 plus 0.001 to "5000.000"; Frequencies F02 to F19 must be 0.001 greater than the previous frequency and 0.001 less than the next frequency. "FREQ ## =(DATA)" for F01 through F20. Data to fixed three decimal places.
K##	K-Factor 1-20 "K-FACT # =(DATA)" for K01 through K09. "K-FACT ## =(DATA)" for K10 through K20. DATA to decimal places as per KD command.
TU	Total Units "100" for gallons "140" for liters "110" for cubic feet "150" for cubic meters "180" for barrels All other integer values from 0 and less than 999 will map to custom units "TOT UNITS =(DATA)" (DATA) shall be: "GAL" for gallons "LIT" for liters "FT3" for cubic feet "M3 " for cubic meters "BBL" for barrels "CUS" for custom These three numbers will be the same as the first three digits of the tag number. Changes to this menu shall cause the changes to the tag number.

Command	Description/Allowed Data/Response
FM	Rate Units "0" for seconds "1" for minutes "2" for hours "3" for days "FLOW UNITS=(DATA)" (DATA) shall be: "SEC" for seconds "MIN" for minutes "HR " for hours "DAY" for days
NB	Max Sample Time "1" to "80" "MAX M TIME=(DATA)"
LF	Out Low "0.000" to a maximum value of the Out High setting "4mA FLOW =(DATA)"
AF	Out High Minimum is the Out Low Setting (LF) to a maximum of the following: "99999.999" if RD = 3 "999999.99" if RD = 2 "9999999.9" if RD = 1 " 99999999" if RD = 0 "20mA FLOW =(DATA)"
PA	Password "0" to "9999" "PASS WORD =(DATA)"
OC	Current Out "0" - Current output follows rate. "1" - Current output set to 4mA. "2" - Current output set to 12mA. "3" - Current output set to 20mA. For "0", response = " Output equal to input." For "1", response = " Output is 4mA." For "2", response = " Output is 12mA." For "3", response = " Output is 20mA."

System Commands Supported by Communications Messages

System Command	Description/Response/Comments
OI	Output 4mA `" Output is  4mA."` Current output set to 4mA.
MO	Output 12mA `" Output is 12mA."` Current output set to 12mA.
OM	Output 20mA `" Output is 20mA."` Current output set to 20mA.
OF	Output = Rate (Input) `" Output equal to input."` Current output follows rate.
AA	Auto Data `"F (DATA) R (DATA) T (DATA)"` The response, not the echo, is sent every two seconds until it receives another message from the master. The `(DATA)` following the F denotes the frequency of the pulses to a precision of three places past the decimal, the `(DATA)` following the R denotes the rate to a precision of three places past the decimal, and the `(DATA)` following the T denotes the total to a precision of three places past the decimal.
DA	Dump All All of the responses in previous table. The CAT1 gives all responses except for the CL command.
UI	Unit Identification `"UNIT MODEL=HIT2A XX YY.ZZ"` Model and software number for the unit. `XX` is the hardware revision number, `YY.ZZ` is the software revision where `YY` is the major software revision and `ZZ` is the minor software revision.

System Command	Description/Response/Comments
RR	Read Rate "FLOW = (DATA)" (DATA) = "0" to the following maximums: "99999.999" if RD = 3 "999999.99" if RD = 2 "9999999.9" if RD = 1 " 99999999" if RD = 0
CN	Adjust 4mA output point "CN=#(DATA)" (DATA) is the integer value that the HIT2A sends to the 4-20mA converter to output 4mA This parameter is passed to the HIT2A to adjust the 4mA output point of the device. This value is used in production at the test step to calibrate the 4mA output point. "CN" will cause an Invalid Command response and absence of the # symbol will cause the HIT2A to ignore the data.
CM	Adjust 20mA output point "CM=#(DATA)" (DATA) is the integer value that the HIT2A sends to the 4-20mA converter to output 20mA This parameter is passed to the HIT2A to adjust the 20mA output point of the device. This value is used in production at the test step to calibrate the 20mA output point. "CM" will cause an Invalid Command response and absence of the # symbol will cause the HIT2A to ignore the data.